Filo di lana al centro?

(R. Visonà)

Nell’articolo che segue (Do you really want to keep the yaw string centred?) Richard Johnson ci dà alcuni suggerimenti basati sulla esperienza sua personale e su quella di altri competenti piloti e costruttori come Klaus Holighaus.
In sostanza il suo suggerimento é:

“In virata è meglio tenere il filo leggermente all’esterno della virata, cioè virare in leggera scivolata”

Per due motivi, uno principale e uno secondario:

1 - Sicurezza
In virata, per evitare un aumento del rollio dovuto alla maggior velocità della semiala esterna è normalmente necessario dare un po’ di barra esterna. Questo fa abbassare l’alettone della semiala <u>interna</u> aumentandone l’angolo di incidenza e quindi la portanza. Maggior angolo di incidenza significa però prossimità all’angolo di stallo (leggi: <u>possibilità di ingresso in vite</u>). Inoltre per contrastare l’effetto bandiera che tenderebbe a far diminuire la cadenza, è necessario dare anche un po’ di piede interno. Risultato: l’aliante è in leggera derapata: piede interno e barra esterna. Se la velocità e sufficientemente alta, il pericolo di entrata in vite è scarso, ma se si vola lenti e magari in aria turbolenta, carichi etc, la possibilità di ingresso in vite esiste.

2 – Minimizzazione della resistenza.
Come detto sopra, abbassare l’alettone della semiala interna aumenta la portanza ma aumenta anche la resistenza. Mentre nel volo rettilineo il filo di lana al centro ci garantisce un’ottimizzazione della resistenza, in virata no.

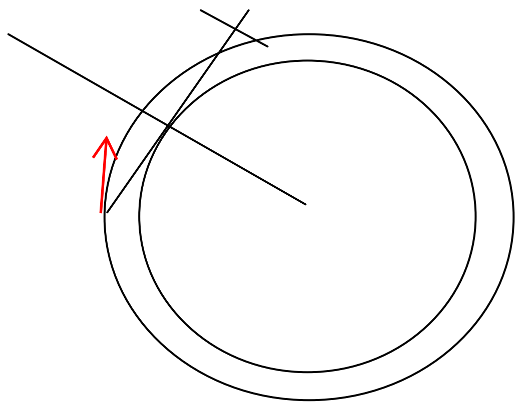
Il suggerimento di R.J. è quindi di mantenere la virata in leggera scivolata.

Chi contrasterà la famosa tendenza ad aumentare l’inclinazione? Risposta: il diedro positivo di cui sono dotati praticamente tutti gli alianti (eccezione: gli acro). La semiala esterna in scivolata viene investita da un flusso con un angolo di incidenza minore di quella interna e questo compensa l’eccesso di portanza dovuto alla maggior velocità.

A supporto delle sue conclusioni R.J. dice anche che un ulteriore motivo per cui il filo va tenuto all’esterno è che normalmente il filo è montato ben avanti al CG dell’aliante (soprattutto nei biposti). Questo significa che il punto di attacco del filo sta percorrendo una traiettoria con un diametro maggiore di quella percorsa dal CG e quindi i filetti fluidi formano un angolo con l’asse longitudinale dell’aliante.

Visti però il rapporto tra raggio di virata e distanza CG-filo di lana, non mi sembra che questo angolo risulti significativo.
Il raggio di virata medio (velocità 80-100 km/h, inclinazione 30-45°) varia da 60 a 140 metri) mentre la distanza CG-filo di lana è al massimo un paio di metri. Quindi, senza perdersi in formule noiose che tengano conto anche dell’inclinazione (a 90° di bank la

differenza sarebbe zero), l’angolo filo di lana /fusoliera è al massimo un paio di gradi, quindi difficilmente apprezzabile.
(La formula per calcolare il raggio di virata é: $r = v^2 / g / \tan\alpha$ dove g è l’accelerazione di gravità e α è l’angolo di inclinazione, ovviamente indipendentemente dal peso, tipo di aeromobile etc.)
Lo schemino qui sotto (non in scala) mostra il concetto.



In conclusione:

- **Virare in leggera scivolata (filo di lana all’esterno, sempre)**

- **Il filo di lana è uno strumento importantissimo per la sicurezza, tenuto conto anche del fatto che molti alianti non hanno più installato a bordo il virosbandometro**

Buoni voli e buona lettura dell’articolo.
RV

Do you really want to keep the yaw string centred?

Richard Johnson, from *Gliding Kiwi*

1. *For Straight Flight* – YES, that minimizes drag and maximizes the sailplane's performance.

2. *For Turns* – NO, not really, because then the sailplane is actually in a slight skid, and more-than-necessary cross-aileron is required to prevent overbanking. This is explained below.

3. *For Circling Flight* – NO, that does not minimize drag, and the possibility of an inadvertent spin entry can be reduced significantly if one maintains a true mild sideslip while circling.

THE WELL-KNOWN German sailplane engineer, designer, Schempp-Hirth factory owner, and sailplane pilot Klaus Holighaus brought the benefits of maintaining a mild sideslip while circling to my attention in 1972 while we were competing at the World Gliding Championships in Yugoslavia. He was flying his new Nimbus 2 sailplane for the German Team, and I was flying an equally fine ASW-17 for the US Team. I was and always have been impressed with his knowledge, generosity and sportsmanship. He died in an unfortunate mountain soaring accident some 9 years ago, but his legend will always live on.

Why maintain a mild sideslip while circling?
Essentially all sailplanes are designed with positive wing dihedral. During a sideslip, this causes the windward wing to achieve a slightly higher angle-of-attack relative to the airstream than the leeward wing, creating a rolling moment toward the leeward wing. This is easy to prove — during straight and level flight while holding the control stick fixed, push on one of the rudder pedals and note your sailplane's roll response. It should definitely roll toward whichever rudder pedal that was depressed. That is known as positive roll stability.

The beneficial effect of positive roll stability is not so obvious during circling flight, but it is still there. The lowered inside wing panel has less airspeed, and hence less lift than the raised outside wing panel. To compensate for that, while keeping the ball centred, one must deflect the lower wing's aileron downward to increase its lift so that its lift equals that of the upper wing. If that's not done, the sailplane will keep increasing its bank angle, resulting in a spiral dive.

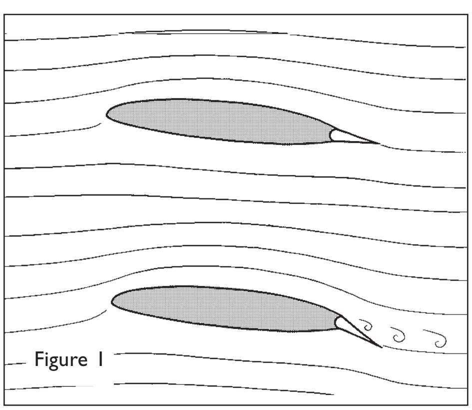


Figure 1

When the lowered wing's aileron is deflected downward, not only is its lift increased, but also its drag is increased, and a skidding turn will be induced. The skid can easily be corrected by adding some top rudder to keep the ball centred. The danger here is that when the aileron is deflected downward, it is more prone to stalling. If that happens, an out-of-control spin will likely result unless corrective action is promptly taken.

Figure 1 shows a cross-section of a sailplane wing airfoil and its airflow streamlines. The upper airfoil presents a relatively high angle-of-attack thermalling condition with the aileron undeflected. Both the upper and lower surface airflows stay attached to the wing surfaces, and near maximum wing lift is achieved. The lower airfoil shows the same airfoil, but with the aileron deflected downward. If the aileron is deflected down far enough, the airflow will separate from the upper portion of the aileron surface, and that will increase the wing drag and decrease its lift. If a pilot then increases the aileron downward deflection angle to try to compensate for its lost lift, it only makes things worse. A spin entry is likely, unless the aileron deflection angle is neutralized, and/or the wing angle-of-attack is promptly reduced.

How may one require less aileron deflection while circling? Just maintain a small angle of sideslip and let the sailplane's dihedral effect provide some additional lift to the lower wing. Figure 2 depicts how the wing dihedral combined with a sideslip increases the lift on the windward wing, and decreases lift on the leeward wing.

Klaus recommended maintaining a gentle sideslip while circling. The optimum sideslip depends to some degree on both the wing's span and its dihedral. After many hours of flying my 16.6m Ventus A and similar sailplanes, I find that my best overall circling performance and handling characteristics occur while the canopy mounted yaw string is deflected about 10° on the high side of the turn (a gentle sideslip actually), because the yaw string forward placement error accounts for about half of the 10°. See section below.

The slip indicator A slip indicator is a curved glass tube filled with a clear fluid within which a ball is free to roll from side-to-side. It's mounted laterally on an instrument panel and is designed to sense and indicate lateral accelerations of the sailplane. I observe that under optimized circling conditions, my ball is *not* centred, but rests about 1/2 ball diameter on the low side of the turn. Figure 3 illustrates a hypothetical sailplane cockpit view while thermalling in a slightly slipping circling flight condition. The instrument panel includes a ball skid indicator, and the canopy sports a typical forward mounted yaw string deflected about 10° toward the high side of the turn.

Winglet problems Winglets are often prone to stalling during slipping or skidding flight. Winglet equipped sailplanes likely need to keep the ball centred to avoid winglet stalling problems. Place some wool tufts on the inboard sides of the winglets and see for yourself during a test flight.

Yaw string longitudinal location Figure 4 depicts a plan view of a sailplane while thermalling. Circling with the yaw string centered actually results in a slightly skidding turn because the yaw string is mounted well ahead of the sailplane's CG. This concept is true, and Figure 4 illustrates that point. The yaw string is mounted about two metres ahead of the sailplane's CG; so the air approaching the yaw string arrives slightly from the left of the sailplane's nose. Another way to view this is to consider the sailplane to be motionless in space, while the thermal is rotating at say 45 knots against the sailplane. That makes it easier to appreciate the effectively curved airflow approaching the nose-mounted yaw string.

Single-seated sailplanes do not often carry slip indicators, but fortunately many two seat training sailplanes come equipped with them mounted on the instrument panels. The canopy mounted yaw string angle errors can easily be seen during turning flight by referring to the true slip indicator. In a tandem two-seater with separate yaw strings, one can compare the difference in the angles between the rear and front cockpit yaw strings.

If the yaw string could somehow be mounted at the sailplane's CG, and utilized by the pilot, the yaw string would then show zero yaw deflection when the sailplane was being flown with the ball centred. Because of its normally well-forward mounting location, the yaw string indicates a slight sideslip, even though the sailplane's more accurate ball shows none. Obviously, the ball more accurately portrays the sailplane's true flight condition.

Magnifying effect of airflow across canopy During both straight ahead yawed flight, and also during skidding and slipping circling flight, the canopy air cross-flow has a magnifying effect on the canopy local airflow direction. The actual sailplane slip or skid angles are likely about half that indicated by the yaw string.

Summary

- Because canopy mounted yaw strings are typically mounted well ahead of the sailplane's CG, they indicate a slight sideslipping condition while turning, when in fact the sailplane is not slipping.
- Better and safer sailplane circling performance can be achieved by maintaining an actual slight 1/2 ball width sideslip while thermalling. When circling in that condition, the yaw string typically needs to ride about 10° on the high side of the turn.
- Winglet equipped sailplanes may suffer stalling on the inboard winglet during the 1/2-ball sideslip. In that case, keeping the ball centred will most likely optimize climb performanc3e. To achieve that, the yaw string still needs to ride about 5° on the high side of the turn.
- For safety's sake never skid a turn, unless a spin entry is intended. *Never fly with the yaw string on the low side during any turn because that is a dangerous skidding flight condition, and too much aileron deflection is required to prevent overbanking.* Skidding is an indication that too much pro-turn rudder is being applied. At low airspeeds that can easily lead to loss of roll control and a dangerous spin.
- It is very important that a yaw string be installed on modern sailplanes, but it is also prudent to have a simple slip indicator mounted on the instrument panel to indicate true slipping or skidding. Next to the airspeed indicator, the yaw string is, in my opinion, the most important sailplane safety instrument.
- Although the ability of a yaw string to correctly indicate a skid or slip is only fair, it is cheap and simple. Its most redeeming feature is its mounting location, squarely in the pilot's forward field-of-view. ❖

Figure 2

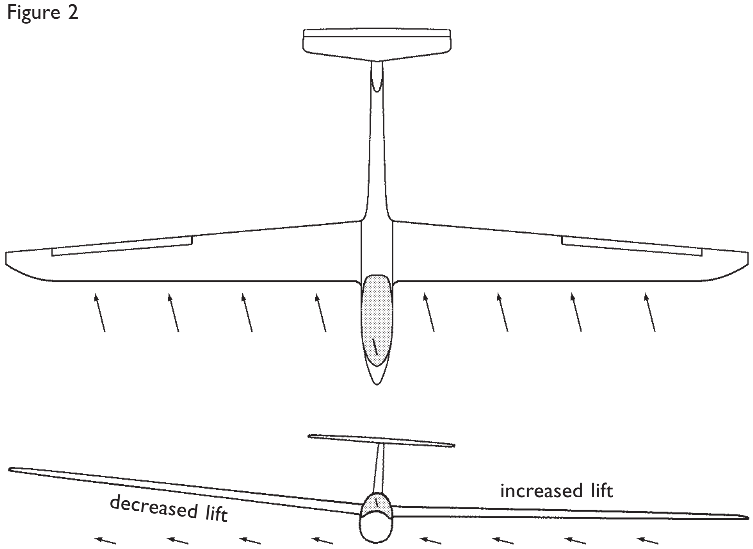
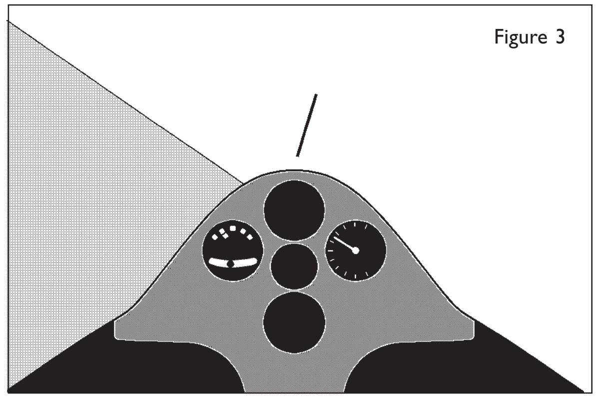


Figure 3



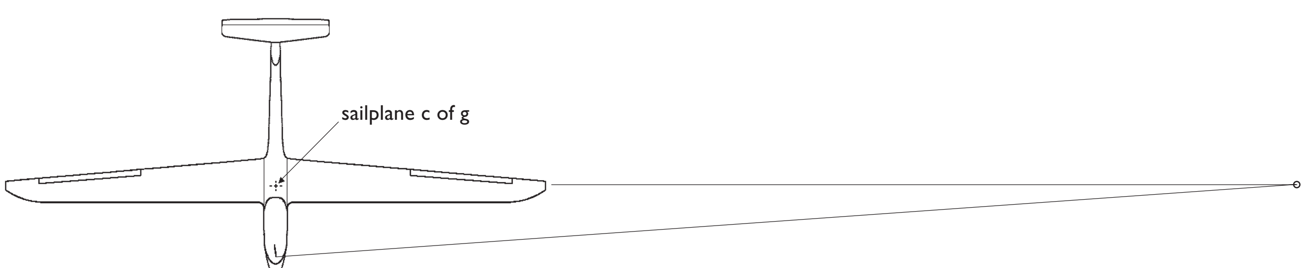


Figure 4